

CLAIMS

1
2 1. (Currently Amended) Apparatus comprising
3 ~~A switching amplifier adapted to drive at least first and second reactive loads,~~
4 means for generating ~~with first and second switching signals, respectively,~~
5 ~~each of said first and second switching signals having respective switching band~~
6 ~~components and at least one respective baseband component, and~~
7 means for applying said first and second switching signals to said first and
8 second reactive loads, respectively,
9 the means for generating generating the switching signals in such a way, and
10 the and the means for applying applying the first and second switching signals to the
11 first and second reactive loads in such a way that causing the baseband components of
12 ~~the first and second switching signals being such that, and said loads being~~
13 ~~interconnected in such a way that, a) the sum of the values of the instantaneous~~
14 ~~currents through said each load is substantially constant, b) substantially all of said at~~
15 ~~least one baseband component of said first switching signal being is a current that~~
16 ~~flows into said first reactive load and c) substantially all of said at least one baseband~~
17 ~~component of said second switching signal being is a current that flows into said~~
18 ~~second reactive load,~~
19 wherein at least one of said reactive loads is a transducer.

2. Canceled.

1 3. (Previously Presented) The invention of claim 1 wherein there are N
2 of said loads and wherein for each of a number of signal variables for each load, the
3 sum of the values of each particular signal variable is substantially constant.

1 4. (Original) The invention of claim 3 wherein said number of signal
2 variables is greater than 1 and less than N.

1 5. (Previously Presented) The invention of claim 1 wherein respective
2 first terminals of each of said loads are connected to a common node through which
3 said current at baseband frequencies flows, said common node being connected to a
4 fixed potential.

1 6. (Currently Amended) The invention of claim 5 wherein each of said
2 loads has a second terminal and wherein said ~~switching amplifier apparatus~~ further
3 comprises means for applying at least the baseband components of said first
4 switching signal between the second terminal of said first load and said common node
5 and for applying at least the baseband components of said second switching signal
6 between the second terminal of said second load and said common node.

1 7. (Previously Presented) The invention of claim 1 further comprising
2 a mechanical load connected to said transducer.

1 8. (Original) The invention of claim 7 wherein said mechanical load
2 includes means for generating acoustic sonar signals.

1 9. (Currently Amended) Apparatus comprising
2 ~~A switching amplifier adapted to drive~~ at least first and second reactive loads,
3 means for generating with at least first and second switching signals,
4 ~~respectively, each of said at least first and second switching signals having respective~~
5 ~~switching band components and at least one respective baseband component,~~
6 means for applying said first and second switching signals to said first and
7 second reactive loads, respectively,
8 the means for generating and the means for applying causing the baseband
9 ~~components of the at least first and second switching signals being such that, and said~~
10 ~~loads being interconnected in such a way that, a) substantially all of the current at~~
11 ~~baseband frequencies flowing that flows~~ out of one or more of said loads at a given
12 time ~~flows to~~ flow into one or more of the others of said loads, b) substantially all of

13 said at least one baseband component of said first switching signal to be ~~being~~ a
14 current that flows into said first reactive load and c) substantially all of said at least
15 one baseband component of said second switching signal ~~being~~ to be a current that
16 flows into said second reactive load,

17 wherein at least one of said reactive loads is a transducer.

1 10. (Previously Presented) The invention of claim 9 further comprising
2 means for connecting respective first terminals of each of said loads to a common
3 power supply node through which said current at baseband frequencies flows.

1 11. (Currently Amended) The invention of claim 10 wherein each of
2 said loads has a second terminal and wherein said ~~switching amplifier apparatus~~
3 further comprises means for applying at least the baseband components of said first
4 switching signal between the second terminal of said first load and said common node
5 and for applying at least the baseband components of said second switching signal
6 between the second terminal of said second load and said common node.

1 12. (Withdrawn-Previously Presented) The invention of claim 11
2 wherein said switching amplifier is further adapted to drive a third reactive load with
3 a third switching signal, said third switching signal having switching band
4 components and at least one baseband component, said third load having a second
5 terminal, and wherein said switching amplifier further comprises means for applying
6 the at least one baseband component of said third switching signal between the
7 second terminal of said third load and said common node.

1 13. (Original) The invention of claim 9 wherein said loads have
2 substantially equal impedance and wherein said baseband components are the inverse
3 of one another.

1 14. (Currently Amended) The invention of claim 9 wherein said
2 ~~switching amplifier~~apparatus further includes at least one power supply terminal and
3 wherein said current flowing out of one or more of said loads flows away from said
4 power supply terminal and said current flowing into one or more of the others of said
5 loads flows toward said power supply terminal.

1 15. (Original) The invention of claim 14 wherein the phases and
2 amplitudes of said baseband components are such that said currents add to zero at
3 substantially all times.

1 16. (Previously Presented) The invention of claim 14 wherein respective
2 first terminals of each of said loads are connected to a common node through which
3 said current at baseband frequencies flows, said common node being at a fixed
4 potential.

1 17. (Original) The invention of claim 9 wherein there are two of said
2 loads, wherein said two loads have substantially equal impedances and wherein the
3 baseband components of said first and second switching signals are of substantially
4 equal magnitude and are substantially the inverse of one another.

1 18. (Withdrawn) The invention of claim 9 wherein said switching
2 amplifier is further adapted to drive a third reactive load with a third switching signal,
3 wherein said first, second and third loads have substantially equal impedances and
4 wherein the baseband components of said first, second and third switching signals are
5 such that they add to zero at substantially all times.

1 19. (Previously Presented) The invention of claim 9 further comprising a
2 mechanical load connected to said transducer.

1 20. (Original) The invention of claim 19 wherein said mechanical load
2 includes means for generating acoustic sonar signals.

1 21. (Currently Amended) The invention of claim 9 wherein said
2 ~~switching amplifier apparatus~~ further includes at least first and second signal paths
3 containing said first and second loads, respectively.

1 22. (Original) The invention of claim 21 wherein alternating polarity
2 currents flow in said first and second signal paths in response to said first and second
3 switching signals, respectively.

1 23. (Original) The invention of claim 22 wherein said first and second
2 switching signals are generated in response to first and second pulse-width-modulated
3 signals, respectively.

1 24. (Currently Amended) The invention of claim 21 wherein said
2 ~~switching amplifier apparatus~~ further includes means for applying said first and
3 second switching signals to said first and second signal paths, respectively, in such a
4 way that at least one switching band component of said first switching signal and at
5 least one switching band component of said second switching signal cancel each other
6 and therefore are substantially isolated from said loads.

1 25. (Original) The invention of claim 24 wherein alternating polarity
2 currents flow in said first signal path in response to said first switching signal and
3 alternating polarity currents flow in said second signal path in response to said second
4 switching signal.

1 26. (Original) The invention of claim 24 wherein

2 said at least one switching band component of said first switching signal and
3 said at least one switching band component of said second switching signal are of
4 substantially the same amplitude and phase, and

5 said means for applying comprises a common-mode inductor in said first and
6 second signal paths.

1 27. (Withdrawn) The invention of claim 21 wherein said switching
2 amplifier is further adapted to drive a third reactive load with a third switching signal,
3 wherein said switching amplifier includes at least a third signal path containing said
4 third load, and wherein said switching amplifier further includes means for applying
5 said first, second and third switching signals to said first, second and third signal
6 paths, respectively, in such a way that at least one switching band component of each
7 of said first, second and third switching signals cancel each other and therefore are
8 substantially isolated from said loads.

1 28. (Withdrawn) The invention of claim 27 wherein alternating polarity
2 currents flow in said first signal path in response to said first switching signal,
3 alternating polarity currents flow in said second signal path in response to said second
4 switching signal, and alternating polarity currents flow in said third signal path in
5 response to said third switching signal.

1 29. (Withdrawn) The invention of claim 27 wherein
2 said at least one switching band component of said first, second and third
3 switching signals are of substantially the same amplitude and phase, and
4 said means for applying comprises a common-mode inductor in said first,
5 second and third signal paths.

1 30. (Previously Presented) The invention of claim 21 wherein
2 each of said loads includes a first terminal and a second terminal,

3 the first terminals of each of said loads are connected to a common node
4 through which said current at baseband frequencies flows, said common node being
5 adapted to be connected to a fixed potential,
6 each said path includes filtering circuitry connected to the second terminal of
7 the respective load, and
8 each of said first and second switching signals comprises an alternating
9 polarity signal impressed across said first and second signal paths, respectively.

1 31. (Original) The invention of claim 21 wherein
2 each of said loads includes a first terminal and a second terminal,
3 the first terminals of each of said loads are connected to a common node
4 through which said current at baseband frequencies flows, said common node being
5 connected to a fixed potential,
6 each said path includes filtering circuitry connected to the second terminal of
7 the respective load, and
8 said first and second switching signals comprise respective signals at first and
9 second potentials applied to the filtering circuitry of said first and second signal paths,
10 respectively.

1 32. (Original) The invention of claim 31 wherein
2 said second potential is substantially equal to said fixed potential, and
3 said filtering circuitry includes at least one energy storage element that stores
4 energy when each said switching signal is at said first potential and that supplies
5 energy to said loads when each said second node is connected to said second
6 potential.

1 33. (Original) The invention of claim 32 wherein
2 said energy storage element is a common-mode inductor having first and
3 second ports in said first and second paths, respectively, and

4 said first and second switching signals have respective switching band
5 components that are of substantially equal magnitude and phase that are canceled by
6 said common-mode inductor.

1 34. (Previously Presented) Apparatus comprising
2 two or more circuit paths each including a respective reactive load, each of
3 said loads having a first terminal connected to the first terminal of each other load, at
4 least one of said loads being a transducer,
5 means for generating for each of said circuit paths an associated pulse-width-
6 modulated signal, each pulse-width-modulated signal alternating between a respective
7 first level and a respective second level at a particular switching frequency, the pulse
8 widths of the pulses of each pulse-width-modulated signal being determined by a
9 respective baseband signal,
10 means responsive to each of said pulse-width-modulated signals for
11 impressing an associated switching signal across the associated circuit path, said
12 switching signal comprising first and second voltages impressed across the associated
13 circuit path when the associated pulse-width-modulated signal is at its first and
14 second levels, respectively,
15 the baseband signals being such that substantially all of the current at
16 baseband frequencies flowing out of one or more of said loads at a given time flows
17 into one or more of the others of said loads, and such that substantially all of the
18 current at baseband frequencies flowing in said two or more circuit paths flows
19 through the respective reactive load.

1 35. (Original) The invention of claim 34 wherein there are N of said
2 circuit paths and wherein the phase of each of the baseband signals differs from the
3 phase of one other of said baseband signals by $360/N$ degrees.

1 36. (Original) The invention of claim 34 wherein said circuit paths
2 include circuitry in common that prevents current at at least said switching frequency
3 from flowing through said loads.

1 37. (Original) The invention of claim 34 wherein said circuit paths
2 include in common circuitry that isolates signals at at least said switching frequency
3 from said loads.

1 38. (Original) The invention of claim 34 wherein said circuit paths
2 include in common circuitry that cancels signals at at least said switching frequency.

1 39. (Original) The invention of claim 34 wherein said switching signals
2 are in phase with one another at said switching frequency and wherein said circuit
3 paths include respective ports of a common-mode inductor that cancels signals at at
4 least said switching frequency, thereby preventing most of the energy in said
5 switching signals at said switching frequency from being applied to said loads.

1 40. (Withdrawn) The invention of claim 39 wherein $N \geq 3$.

1 41. (Previously Presented) The invention of claim 34 further comprising
2 a mechanical load connected to said transducer.

1 42. (Original) The invention of claim 41 wherein said mechanical load
2 includes means for generating acoustic sonar signals.

43 – 51. Canceled.

1 52. (Withdrawn-Previously Presented) Apparatus comprising

2 means for generating at least first and second switching signals having the
3 same switching frequency and having respective fundamental frequency components
4 that have a particular phase relationship with one another and said first and second
5 switching signals having respective baseband components at at least one baseband
6 frequency that do not have said particular phase relationship with one another,
7 at least first and second reactive loads, at least one of said loads being a
8 transducer,
9 a rejection filter that cancels signals applied to respective ports thereof that
10 have said predetermined phase relationship, and
11 means for applying said at least first and second switching signals to
12 respective circuit paths that include said at least first and second loads, respectively,
13 and that include respective ports of said rejection filter, whereby signals at said
14 fundamental switching frequency are isolated from said loads while said baseband
15 components at at least said one baseband frequency are applied to said loads,
16 wherein substantially all of the baseband component of said first switching
17 signal at said at least one baseband frequency is a current that flows into said first
18 reactive load and substantially all of the baseband component of said second
19 switching signal at said at least one baseband frequency is a current that flows into
20 said second reactive load..

1 53. (Withdrawn) The invention of claim 52 wherein said fundamental
2 frequency components are in phase with one another, said baseband components are
3 the inverse of one another, and said rejection filter is a common-mode inductor.

1 54. (Withdrawn) The invention of claim 52 wherein
2 said at least first and second switching signals comprises at least first, second
3 and third switching signals,
4 said apparatus further comprises a third reactive load, and

5 said apparatus further comprises means for applying said third switching
6 signal to a respective circuit path that includes said third load and that includes a
7 respective port of said rejection filter.

1 55. (Withdrawn) The invention of claim 54 wherein said rejection filter
2 is a common-mode inductor.

1 56. (Withdrawn) The invention of claim 52 wherein said rejection filter
2 is a common-mode filter, wherein said switching signals are phased in such a way
3 that, and are applied to said common-mode filter in such a way that, said fundamental
4 frequency components comprise a common-mode input signal for said common-
5 mode filter and said baseband components are differential mode signals for said
6 common-mode filter.

1 57. (Withdrawn-Previously Presented) The invention of claim 56
2 wherein a mechanical load is connected to said transducer.

1 58. (Withdrawn-Previously Presented) The invention of claim 57
2 wherein said mechanical load includes means for generating acoustic sonar signals.

59-62. Canceled.

1 63. (Previously Presented) A switching amplifier operating at a
2 particular switching frequency, the switching amplifier comprising
3 at least first and second circuit paths,
4 each of said paths comprising switching circuitry, a load filter, a respective
5 port of a common-mode inductor and a transducer, all connected in series, each
6 transducer having a terminal that is connected to a power supply node in common
7 with each other transducer, each load filter having a passband that includes said

8 particular switching frequency and having a stop band at frequencies higher than said
9 particular switching frequency,

10 said switching circuitry being operative in response to a first pulse-width-
11 modulated signal to cause first and second voltages of a first switching signal to be
12 alternately impressed between the load filter of said first circuit path and said
13 common node and being further operative in response to a second pulse-width-
14 modulated signal to cause first and second voltages of a second switching signal to be
15 alternately impressed between the load filter of said second circuit path and said
16 common node,

17 said first and second switching signals having respective fundamental
18 switching components that are of substantially equal magnitude and phase so that
19 they are canceled by said common-mode inductor, said first and second switching
20 signals each further having at least one respective baseband component, the baseband
21 components of said first and second switching signals being such that substantially all
22 of the current at baseband frequencies flowing out of one or more of said transducers
23 at a given time flows into one or more of the others of said loads, and

24 substantially all of said at least one baseband component of said first
25 switching signal being a current that flows into one of said transducers and
26 substantially all of said at least one baseband component of said second switching
27 signal being a current that flows into another of said transducers.

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2 64. (Original) The invention of claim 63 wherein the phases and
3 amplitudes of said baseband components are such that said currents add to zero at
4 substantially all times.

1 65. (Previously Presented) The invention of claim 63 wherein said
2 transducers have substantially equal impedance and wherein said baseband
3 components are the inverse of one another.

1 66. (Previously Presented) The invention of claim 63 wherein said
2 switching amplifier includes at least one power supply terminal and wherein said
3 current flowing out of one or more of said transducers flows away from said power
4 supply terminal and said current flowing into one or more of the others of said
5 transducers flows toward said power supply terminal.

1 67. (Previously Presented) The invention of claim 63 wherein there are
2 two of said transducers having substantially equal impedances and wherein the
3 baseband components of said first and second switching signals are of substantially
4 equal magnitude and are substantially the inverse of one another.

1 68. (Previously Presented) The invention of claim 67 wherein a
2 mechanical load is connected to at least one of said transducers.

1 69. (Original) The invention of claim 68 wherein said mechanical load
2 includes means for generating acoustic sonar signals.

70 - 78. Canceled